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1. What Really Happened: Bruce/Brenda/David Reimer and
Gender Development
2. The Visual System: A Brief Introduction

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What Really Happened: Bruce/Brenda/David Reimer and Gender Development

INTRODUCTION

This case study ⁽¹⁾ is sometimes called "The circumcision that went wrong" or "John/Joan". It is particularly interesting to psychology because two identical male twins are involved, and one was raised as a boy (Brian), the other as a girl (Bruce/Brenda Reimer) for most of their childhood. This seems like the perfect twin study ⁽²⁾.

The positive aspects of the case are reported by John Money ⁽³⁾, but this has been challenged recently. Diamond (1982) began to raise doubts suggesting that Brenda Reimer was having problems, among general issues on intersex children in a BBC programme. For example, she was called "cave-woman" by her classmates because her appearance and behaviour were so unfeminine.

Diamond and Sigmundson (1997) was based upon interviewing David in 1993. They called it the case of "John/Joan", and told the truth about it not being a success ⁽⁴⁾. David Reimer made his identity known through John Colapinto's article in "Rolling Stone" magazine in December 1997 ⁽⁵⁾, and then in the book "As Nature Made Him" ⁽⁶⁾.

Table 1 lists the main events of David Reimer's life.

Born: 22 August 1965 (named Bruce)

Circumcision operation goes wrong: 27 April 1966 (8 months old)

Operation to change fully to girl: 3 July 1967 (22 months old; now called Brenda and raised as girl)

Brenda told truth about birth identity: 14 March 1980 (14 years old; now called David and raised as boy)

Operations to change to male: 1980-81 (15-16 years old)

Shot himself: 4 May 2004 (38 years old)

Table 1 - Main events of David Reimer's life.

HISTORY

Bruce Reimer and his twin brother, Brian, were born four weeks early on 22th August 1965 in Winnipeg, Canada. Bruce was older by twelve minutes, but was born underweight, so he was kept in hospital to fatten up.

At seven months old, Janet Reimer (mother) noticed the boys' foreskins seemed to be sealing up at the tip making it difficult for them to urinate. The doctor diagnosed this as phimosis ⁽⁷⁾, and operations for circumcision were arranged.

The operation took place on 27th April 1966. Colapinto (2000) reconstructed the events from court papers filed later.

Bruce was chosen for the operation first, and was given a general anaesthetic because of being eight months old. The operation was relatively simple and involved cutting away the foreskin. The doctor preferred to remove the foreskin by burning it away with a "Bovie cautery machine". Electricity is used to heat a small needle (similar to a soldering iron).

Initially, the machine did not seem to work on a low temperature, so the temperature was increased. Because the temperature was now so high, the machine burnt away more than the foreskin, and left the penis severely damaged. Colapinto (2000) described it thus: "A wisp of smoke curled up from the baby's groin. An aroma as of cooking meat filled the air" (p12).

A subsequent emergency operation was needed to attach a catheter to the bladder. Brian Reimer was not operated on that day ⁽⁸⁾.

The father, Ron, reported that Bruce's penis looked "like a piece of charcoal". In the next few days, after the operation, Bruce's penis dried up and pieces broke off. So there was no penis, and it was very difficult to urinate. Thus the need for the catheter.

Doctors were unsure about what to do, in terms of surgery, but ten months after the operation (February 1967), the family were contacted by John Money from Johns Hopkins Hospital, Baltimore. He had seen about Bruce in the newspaper. Money, at the time, was pioneering work on trans-sexuals ⁽⁹⁾. He proposed to the Reimers to do the full sex change operation on Bruce, as it did not matter the sex a baby was born because they could be reared as another successfully.

Bruce was to be called Brenda and treated as a girl. On 3rd July 1967, at 22 months old, Bruce was given full surgical castration (bilateral orchidectomy - removal of both testicles), and a "rudimentary exterior vagina". Ideally a further operation would have been needed to develop the vagina nearer puberty, but Brenda resisted and it never happened.

After years of problems, on 14th March 1980, Brenda (aged 14 years) was told the truth by her father. Very soon after finding out, Brenda changed her name to David, and started to dress like a boy. He received injections of testosterone, and began surgery to revert back to the

biological sex of male (22 October 1980 double mastectomy, and 2nd July 1981 phallic reconstruction - phalloplasty).

Despite marrying as David and attempting to settle down to an ordinary life, his past affected him, and on 4th May 2004 he committed suicide with a shotgun at 38 years old. He had recently become unemployed, lost money in a bad investment, and was temporarily separated from his wife.

THEORY AND CONTROVERSY

John Money had developed the theory of gender development ⁽¹⁰⁾ which emphasised the role of upbringing ⁽¹¹⁾. He had studied a number of intersex individuals ⁽¹²⁾, where the biological sex is ambiguous, and depending how they were raised mattered most. In other words, gender identity ⁽¹³⁾ was not biological, but based on the environment and learning.

From the sum total of hermaphrodite evidence, the conclusion that emerges is that sexual behaviour and orientation as male or female does not have an innate, instinctive basis. In place of a theory of instinctive masculinity or femininity which is innate, the evidence of hermaphroditism lends support to a conception that, psychologically, sexuality is undifferentiation at birth and that it becomes differentiated as masculine and feminine in the course of the various experiences of growing up (Money 1955 quoted in Colapinto 2000 pp23-24).

Money supported the idea of a critical period ⁽¹⁴⁾ ("gender identity gate") for gender identity at 2 -3 years old.

Despite the efforts to raise Brenda as a girl, there were problems. The choice of toys were boys' ones, and lots of fights at school. A commonly quoted example was that Brenda stood and faced the toilet bowl when urinating (as men do).

Though few people outside the family knew the truth, Brenda's boyish behaviour was noted. The kindergarten teacher, Audrey McGregor, said "She was more a boy in the nature of things" (Colapinto 2000 p61). Problems at school were normal for Brenda from the beginning, including retaking the first grade.

Brian is quoted as saying: "There was nothing feminine about Brenda.. She walked like a guy. Sat with her legs apart. She talked about guy things.. She played with my toys.." (Colapinto 2000 p57).

Over the next few years, there were regular visits to see John Money, which David Reimer described to John Colapinto as unpleasant, to say the least. He felt that Money's main intention was to bully him into being a girl.

The case study that became known in psychology textbooks reported that Brenda was developing as a girl with few problems ⁽¹⁵⁾. John Money announced the positive details at the annual meeting of the American Association for the Advancement of Science in Washington in December 1972. Fuller details appeared in "Man and Woman, Boy and Girl" (Money and Ehrhardt 1972).

Money (1975) wrote about Brenda (4.5 years old) quoting her mother: "One thing that really amazes me is that she is so feminine.. She just loves to have her hair set.." (quoted in Masters et al 1995 p206).

"By any measure, the account portrayed the experiment as an unqualified success. In comparison with her twin brother, Brenda provided what Money variously described as an 'extraordinary' and a 'remarkable contrast'" (Colapinto 2000 pp68-69). It appeared that Brenda was "sailing contentedly through childhood as a genuine girl" (Linda Wolfe in "New York Times Book Review" May 1975; quoted in Colapinto 2000).

But there were critics and concerns including:

a) Psychiatrists, Keith Sigmundson and Doreen Moggey, who saw Brenda in 1976, were concerned that she was "just a boy with long hair in girl's clothes". Moggey admitted: "when you read the papers (Money's accounts) and when you saw the kid, they didn't go together.. That wasn't the child he was describing" (Colapinto 2000 p114).

While Janice Ingimundson (child psychiatrist), in 1977, found her a "tough girl": "A rather boyish-looking girl.. You'd talk to her.. and conventionally masculine interests would come forward" (Colapinto 2000 p122).

b) Milton Diamond (eg: 1997a and 1997b) and Zuger (1970) were critical of Money's theory of gender development. It was Diamond's article, with Keith Sigmundson in 1997, that first fully told the negative side of the Reimer case.

Two controversies remain from this case study:

i) John Money's emphasis on the success of the gender reassignment of Brenda despite full knowledge of the problems.

The desire for the evidence to fit the theory rather than the other way around (which is the way of science)

does give a subjective interpretation to the whole case.

Also Colapinto (2000) included the accusation that Money stopped alternative views being expressed and published through his influence in academia. This reached its peak in an altercation with Milton Diamond in September 1973 at a conference in Yugoslavia. Money was influential and was called "one of the greatest sex researchers of the century" in 1997 ⁽¹⁶⁾.

ii) Reimer was interviewed regularly alone by Money, and a number of controversial techniques were used.

These included long discussions about genitalia, looking at pictures of childbirth, coital mimicry with his brother, and being introduced to a trans-sexual.

David speaking to Colapinto in 1997 was very angry about these interviews: "It was like brainwashing.. I'd give just about anything to go a hypnotist to black out my whole past. Because it's torture. What they did to you in the body is sometimes not near as bad as what they did to you in the mind - with the psychological warfare in your head" (Colapinto 2000 ppxii-xiii).

But Richard Green (2004) suggested that the recall of sexual discussions by David could be false memories.

EVALUATIVE FOOTNOTES

1. The case study method is concerned with collecting a large amount of information about the subject of the study, usually an individual. It has a number of advantages and disadvantages (table 2).

Case studies tend to have less ethical concerns than other research methods based on the BPS (1991) code of conduct for psychological research. The main concerns are invasion of privacy and confidentiality, but these are overcome by consent from the participant, and use of a pseudonym when reporting the details.

2. Twin studies with identical (monozygote) twins allow the comparison of behaviour to see what aspects are genetic because both twins have exactly the same genes, and what part of behaviours are caused by the environment.

3. Details of case study in Money and Ehrhardt (1972), Money (1974), Money (1975), Money and Tucker (1975), and Hutchison (1978), but not mentioned in Money (1988) or Money and Musaph (1991).

4. "Diamond and Sigmundson suspect that most boys-made-girls will, like John, reject their female identity by the time they reach puberty" (Gorman 1997 p53).

ADVANTAGES

- builds up detailed picture
- not artificial
- source of future hypotheses
- useful for treating individual problems
- helps to discover how past influences present
- studying unusual may help with usual
- outstanding cases can be studied
- insight can be gained from one example
- tentative support for theory or challenge orthodox view
- documents rare cases

DISADVANTAGES

- not possible to generalise findings
- depends on accuracy of memory of participants
- past events sometimes explained based on current state of mind
- cause and effect not possible to establish
- criteria for inclusion of information is subjective
- situation and time bound
- poor replicability
- biased observer

Table 2 - Advantages and disadvantages of the case study method.

5. David Reimer had granted two TV interviews in 1997 but with his face obscured and voice disguised. He fully revealed his identity as "John/Joan" with an appearance (with John Colapinto) on the "Oprah Winfrey Show" (among other US TV talk shows) in 2000.

6. "Horizon" made two recent programmes about Reimer - "The boy who was turned into a girl" (2000) and "Dr.Money and the boy with no penis" (2004).

7. Phimosis is foreskin contraction ie the foreskin is stuck to the head of the penis making urination difficult (John MacFarlane www.Netdoctor.co.uk accessed 13/10/05), and infection under the foreskin is a risk (Dawson and Whitfield 1996).

8. Little attention is paid to the other twin, Brian. Far from being the control group in this "experiment", he had his own problems including a possible deliberate overdose in 2002, and schizophrenia ("Horizon: Dr.Money and the Boy with No Penis" 2004; BBC Television).

9. "Trans-sexual" refers to an individual who has undergone sex change (or gender reassignment) operations, either male to female (MTF) or female to male (FTM). "Transgender" is sometimes used, but this includes transvestites (cross-dressers), trans-sexuals, intersexuals/hermaphrodites, and eunuchs (Baird 2001).

10. John Money proposed the Theory of Gender Neutrality (eg: Money and Ehrhardt 1972; Money 1980a; Money and Wiedeking 1980). Children are born gender neutral and it is upbringing that determines the gender of a child.

There are a number of other theories that explain the development of gender of children including:

- i) Biological explanations - biological sex at birth determines the gender;
- ii) Social Learning Theory (eg: Bandura 1986);
- iii) Cognitive-Developmental Theory (Kohlberg 1966);
- iv) Psychoanalytic Theory (eg: Freud 1933).

11. The nature versus nurture debate is a key debate in psychology. The nature side argues that behaviour is instinctive or inherited, while the nurture side emphasises the influence of environment and upbringing. The nature side for gender development includes biological explanations, while Money is on the nurture side.

Unusual case studies are important as evidence to support each side of the nature-nurture debate. Examples of other cases quoted by Colapinto (2000):

a) Kenneth Zucker, in 1997, quoted a case study very similar to Reimer of a bungled circumcision in 1971 in Canada. The seven-month-old was reassigned as a girl, and grew up with no "dysphoric feelings about being a woman" (see Bradley et al 1998). But, as an adult, this woman does a typically "blue-collar" male job, and has had exclusively relationships with women.

b) Bernado Ochoa, in 1998, reported a boy in Colombia who had similar experiences as Reimer, but at fourteen years old demanded to be reassigned as a boy.

c) "Antonio" and "Baby Doe" - two newborn boys at Atlanta Northside Hospital in 1985 had similar accidents. The parents of one boy opted for female reassignment ("Baby Doe"), and the others asked for an artificial penis ("Antonio"). Details of these cases were maintained private by the courts, but Colapinto did discover that at fourteen years old, "Antonio" seemed happy with being male. No details of the other case could be ascertained by Colapinto.

12. The situation of intersex individuals or those with

ambiguous genitalia is that they tend to have a "somewhat vagina like opening" and "a phallic structure of a size and shape that could be described as either an enlarged clitoris.. or a micropenis" (Colapinto 2000 p216).

Surgery is performed on newborns based on the decision of which sex to raise the child. If the penis is less than one inch (2.5cm) at birth, then the tendency is to perform surgery to "make" female, and if the clitoris is larger than one quarter of an inch (0.9cm), the decision will be to "make" male (Baird 2001). About 2000 babies in the US each year have some kind of surgery for ambiguous genitalia (Sadock and Sadock 2003).

Kessler (1998) questioned the assumptions about "ambiguous genitals": "They (obstetricians) seem to know ambiguity when they see it.. the phrase 'ambiguous genitals' is used freely with no apparent need to define what 'ambiguous' means in this context". Furthermore, she said: "Ambiguity is at least partially determined by factors such as who is looking, why they are looking, and how hard they are looking.. How hard one 'looks' at genitals and what one 'sees' is not constrained by the optic nerve but by ideology".

Table 3 gives a classification of intersexual disorders (some of them exceptionally rare).

Hermaphroditism is where the individual has functioning sex organs of both sexes. It tends to be very rare. For example, Cheryl Chase with ambiguous genitalia at birth was raised as a boy. Initially treated as Charlie, at 1 years old, it was decided to reassign as a girl (Cheryl). This case is different to Reimer because Chase was a "true" hermaphrodite with both ovarian and testicular tissue.

13. "Gender identity" is how the individual feels about themselves (ie male, female; masculine, feminine, androgynous). "Biological sex" is the sexual identity of the individual based on their biological make-up (ie: biological male, biological female, intersex/hermaphrodite).

Biological sex is determined at a number of levels (Hutt 1978) (table 4).

CONDITION	DESCRIPTION
virilizing adrenal hyperplasia (adrenogenital syndrome)	XX (genetic female) with excess androgens (hormones) in womb; male appearance of genitals eg enlarged clitoris and fused labia
Turner's syndrome	X0 (no second X chromosome); generally female appearance of genitals
Klinefelter's syndrome	XXY (male with extra X chromosome); male with small penis and rudimentary testes
"Supermales"	XYY (extra Y chromosome); eg: taller
Androgen insensitivity syndrome (AIS) (testicular feminizing syndrome)	XY (genetic male); external genitalia appear female; can have breasts in extreme cases
Enzymatic defects in XY genotype	Interruption in testosterone in womb; ambiguous or female looking genitals (Sadock and Sadock 2003)
Hermaphroditism	Both testes and ovaries; 60 cases in past 100 years in Europe and North America (Money 1986)
Pseudohermaphroditism	XX with masculine-looking genitals; XY with rudimentary testes
"Superfemales"	XXX ("super-X syndrome"); XXXX; XXXXX; XXXY (Caroline Cossey - male to female trans-sexual; "Open to Question" 1992; BBC Television)
5-alpha-reductase deficiency	Problem with testosterone similar to AIS (Mealy 2000); assumed to be female at birth but penis develops at puberty; called "kwolu-aatmwol" (New Guinea) meaning "female thing-transforming-into-male thing" (Stainton Roger and Stainton Rogers 2001); "guevodoces" (Dominican Republic) meaning "balls at twelve" (Imperato-McGinley et al 1974)

Table 3 - Different types of intersexual disorders.

Usually these levels work together, but in exceptional cases, they may be differences eg: testosterone insensitivity (or testicular feminizing syndrome). This produces a female appearance but male

chromosomes and testes. A Spanish female athlete, Maria Patino, at the 1992 Olympic Games was disqualified for having XY chromosomes (Bown 1992).

	MALE	FEMALE
Chromosomes	XY	XX
Reproductive organs	testes	ovaries
Dominant hormones	testosterone	oestrogen/ progesterone
Internal organs that link reproductive organs and external genitalia	Wolffian duct	Mullerian duct
External genitalia	penis	vagina/clitoris

Table 4 - Levels of determining biological sex.

Money (1968/1994) argued for eight levels in determining gender:

- i) Chromosomes;
- ii) Foetal gonad for development of testes (in males) or ovaries (in females);
- iii) Foetal hormones;
- iv) Foetal genitalia;
- v) Foetal brain development which responds to sex hormones;
- vi) Assigned gender (or sex of rearing);
- vii) Gender identity - personal sense of gender;
- viii) Pubertal hormones.

14. A critical period is a certain amount of time during which learning must take place, and after that period, learning cannot happen. For gender development, Money felt that after the age of three years children could not change their gender because it was now fixed. Before that time, children could learn a new gender.

15. Older textbooks (ie: pre-1997) reported the case study as supporting the view that gender identity was learnt. For example, Gross (1992) used the source of Money (1974) to say that "At nine years, although 'he' had been the dominant one since birth, 'he' expressed this by being a 'fussy little mother' to 'his' brother" (p686).

While Malim and Birch (1998) said that "According to the parents, this reassignment of sex was very successful" (p518). An earlier edition of Atkinson et al (1993), using Money (1980b), concluded that "Reports indicate that both children (Brenda and Brian) grew up

secure in their respective sex roles" (p405).

16. John Money had studied a number of other unusual cases of gender development, which were used to support the view that how the individual is raised matters most for gender development:

i) Money and Ehrhardt (1972) (and Money and Schwartz 1977) - girls with adrenogenital syndrome raised as boys initially, but were reassigned as girls before three years old.

ii) Money, Hampson and Hampson (1957) (and Money 1971; Money 1984) - matched pairs of individuals with adrenogenital syndrome, where one of the pair was raised as a boy and the other as a girl.

iii) Money and Ehrhardt (1972) ten individuals with testicular feminizing syndrome reared as females.

iv) Money et al (1984) 72 individuals with congenital virilizing adrenal hyperplasia and androgen-insensitivity syndrome.

v) Other cases and follow-ups - Money and Ogunro (1974) ten genetic male intersexual cases; Money and Matthews (1982); Money et al (1986) 32 male hermaphrodites assigned as girls.

vi) General works on intersexuality including case studies - Money (1995); Money (1987); Money and Russo (1979); Money, Hampson and Hampson (1955).

Money has written a lot of academic papers and books on the subject: in his book "Gay, Straight and In-between" (1988), he lists sixty-two references, either individual (32) or co-authored.

The results of these case studies are debated at length: do the children grow up as the gender of their upbringing or are they products of their biological sex?

REFERENCES

Atkinson, R.L; Atkinson, R.C; Smith, E.E & Bem, D.J (1993) Introduction to Psychology (11th ed), Fort Worth: Harcourt Brace Jovanovich

Baird, V (2001) The No-Nonsense Guide to Sexual Diversity, London: New Internationalist

Bandura, A (1986) Social Foundations of Thought and Action: A Social Cognitive Theory, Englewood Cliffs, NJ: Prentice-Hall

Bown, W (1999) Sex-test confusion could create havoc at Olympics, New Scientist, 18/1, p14

Bradley, S.J; Oliver, G.D; Chernick, A.B & Zucker, K.J (1998)

Experiment of nurture: Ablatio penis at two months, sex reassignment at seven months, and a psychosexual follow-up in young adulthood, *Pediatrics*, 102, 1, E9

BPS (1991) Code of Conduct Ethical Principles and Guidelines, Leicester: British Psychological Society

Calopinto, J (2000) *As Nature Made Him*, New York: HarperCollins

Dawson, C & Whitfield, H (1996) Common paediatric problems, *British Medical Journal*, 18/5, 1291-1294

Diamond, M (1977a) Sexual identity and sexual orientation in children with traumatized or ambiguous genitalia, *Journal of Sexual Research*, 34, 199-211

Diamond, M (1977b) Human sexual development. In Beach, F (ed) *Human Sexuality in Four Perspectives*, Baltimore: John Hopkins University Press

Diamond, M (1982) Sexual identity, monozygotic twins reared in discordant sex-roles and a BBC follow-up, *Archives of Sexual Behaviour*, 11, 181-186

Diamond, M & Sigmundson, H.K (1997) Sex reassignment at birth, *Archives of Pediatric and Adolescent Medicine*, 151, 298-304

Freud, S (1933) *New Introductory Lectures in Psychoanalysis*, New York: Norton

Gorman, C (1997) A boy without a penis, *Time*, 24/3, p53

Green, R (2004) speaking on *Horizon: Dr.Money and the Boy with No Penis*, BBC Television

Gross, R.D (1992) *Psychology: The Science of Mind and Behaviour* (2nd ed), London: Hodder & Stoughton

Hutchison, J.B (1978) *Biological Determinants of Sexual Behaviour*, Chichester: John Wiley

Hutt, C (1978) Sex role differentiation in social development. In McGurk, H (ed) *Issues in Childhood Social Development*, London: Methuen

Imperato-McGinley, J; Guerro, L; Gautier, T & Peterson, R.E (1974) Steroid 5-reductase deficiency in men: An inherited form of male pseudohermaphroditism, *Science*, 186, 1213-1216

Kessler, S.J (1998) *Lessons from the Intersexual*, New Brunswick, NJ: Rutgers University Press

Kohlberg, L (1966) A cognitive-developmental analysis of children's sex-role concepts and attitudes. In Maccoby, E.E (ed) *The Development of Sex Differences*, Stanford: Stanford University Press

Malim, T & Birch, A (1998) *Introductory Psychology*, Basingstoke: Macmillan

Masters, W.H; Johnson, V.E & Kolodny, R.C (1995) *Human Sexuality* (5th ed), New York: HarperCollins

Mealy, L (2000) *Sex Differences: Developmental and Evolutionary Strategies*, San Diego: Academic Press

Money, J (1955) Hermaphroditism, gender and precocity in hyperadrenocorticism: Psychologic findings, *Bulletin of John Hopkins Hospital*, 96, 253-264

Money, J (1968/1994) *Sex Errors of the Body and Related Syndromes*, Baltimore: Brooks

- Money, J (1971) Sexually dimorphous behaviour, normal and abnormal. In Kretchner, N & Walcher, D.N (eds) Environmental Influences on Genetic Expression, Washington DC: US Government Printing Office
- Money, J (1974) Prenatal hormones and postnatal socialisation in gender identity differentiation. In Cole, J.K & Dienstbier, R (eds) Nebraska Symposium on Motivation, Lincoln: University of Nebraska Press
- Money, J (1975) Ablatio penis: Normal male infant sex reassigned as a girl, Archives of Sexual Behaviour, 4, 65-72
- Money, J (1980a) Love and Love Sickness, Baltimore: John Hopkins University Press
- Money, J (1980b) Endocrine influences and psychosexual status spanning the life cycle. In Van Praag, H.M (ed) Handbook of Biological Psychiatry, New York: Marcel Dekker
- Money, J (1984) Part III: Matched-pair theory from two cases of micropenis syndrome concordant for diagnosis and discordant for sex of assignment, rearing, and puberty, International Journal of Family Psychiatry, 5, 375-381
- Money, J (1986) Venuses Penuses: Sexology, Sexosophy and Exigency Theory, Buffalo, NJ: Prothemus
- Money, J (1987) Sin, sickness or status? Homosexual gender identity and psychoneuroendocrinology, American Psychologist, 42, 384-399
- Money, J (1988) Gay, Straight and In-between, New York: Oxford University Press
- Money, J & Ehrhardt, A.A (1972) Man and Woman, Boy and Girl, Baltimore: John Hopkins Press
- Money, J & Matthews, D (1982) Prenatal exposure to virilizing progestins: An adult follow-up study of twelve women, Archives of Sexual Behaviour, 11, 73-83
- Money, J & Musaph, H (1991) Biographies of Gender and Hermaphroditism in Paired Comparisons, New York: Elsevier
- Money, J & Ogunro, C (1974) Behavioural sexology: 10 cases of genetic male intersexuality with impaired prenatal and pubertal androgenization, Archives of Sexual Behaviour, 3, 181-205
- Money, J & Russo, A.J (1979) Homosexual outcome of discordant gender identity/role in childhood: Longitudinal follow-up, Journal of Pediatric Psychology, 4, 1, 29-41
- Money, J & Schwartz, M (1977) Dating, romantic and non-romantic friendships, and sexuality in 17 early-treated adrenogenital females, aged 16-25. In Lee, P.A et al (eds) Congenital Adrenal Hyperplasia, Baltimore: University Park Press
- Money, J & Tucker, P (1975) Sexual Signatures, Boston: Little Brown
- Money, J & Wiedeking, C (1980) Gender identity/role: Normal differentiation and its transportations. In Wolman, B.B & Money, J (eds) Handbook of Human Sexuality, Englewood Cliffs, NJ: Prentice-Hall
- Money, J; Devore, H & Norman, B.F (1986) Gender identity and gender transposition: Longitudinal outcome study of 32 male hermaphrodites assigned as girls, Journal of Sexual and Marital Therapy, 12, 165-181
- Money, J; Hampson, J.G & Hampson, J.L (1955) Hermaphroditism: Recommendations concerning assignment of sex, change of sex and psychological management, Bulletin of John Hopkins Hospital, 98, 43-57
- Money, J; Hampson, J.G & Hampson, J.L (1957) Imprinting and the establishment of gender roles, American Medical Association Archives of Neurology and Psychiatry, 77, 333-336

Money, J; Schwartz, M & Lewis, N.G (1984) Adult heterosexual status and fetal hormonal masculinization and demasculinization: 46 XX congenital virilizing adrenal hyperplasia and 46 XY androgen-insensitivity syndrome, compared *Psychoneuroimmunology*, 9, 405-414

Sadock, B.J & Sadock, V.A (2003) *Kaplan and Sadock's Synopsis of Psychiatry* (9th ed), Philadelphia: Lippincott Williams & Wilkins

Stainton Rogers, W & Stainton Rogers, R (2001) *The Psychology of Gender and Sexuality*, Buckingham: Open University Press

Zuger, B (1970) Gender role determination: A critical review of evidence from hermaphrodites, *Psychosomatic Medicine*, 32, 5, 449-467

Kevin Brewer

Article written October 2005

The Visual System: A Brief Introduction

Perception is the process by which individuals make sense of the world. Perception can be divided into three parts:

i) Sensation - the entering of raw data into the senses (light to the eyes, sound to the ears, smell to the nose, taste to the mouth, and touch to the skin senses);

ii) Sensory information processing - the transmission of the information from the senses to the particular areas of the brain for interpretation;

iii) Interpretation - the sensory information is assembled into patterns which make sense of the world.

Most research has been carried out on the visual system and visual perception, which is the sense concentrated upon here.

CHARACTERISTICS OF THE EYE AS A SENSE ORGAN

Each sense organ has certain characteristics which determine the information processed by the brain.

1. Selective - certain information is ignored and other information is focused upon; eg: blood vessels in the eye are not seen.

2. Adaptation - due to experience, certain information is ignored; eg: objects moving in front of the eye when driving are ignored if on the other side of motorway.

3. Absolute threshold - the eye has a minimum threshold for vision: this is the smallest magnitude of data that can be sensed. It was estimated to be a candle flame at 30 miles on a dark, clear night (Atkinson et al 1990).

But some researchers argue that the threshold can vary depending upon expectations, motivation, individual differences in eyesight, and the time of the day.

4. The eye responds to a particular form of information - lightwaves in part of the spectrum. Thus we cannot see X-rays or soundwaves.

5. A specialist structure, the eye, collects light and converts it to electrical messages on the retina, which are sent to the brain.

6. Visual information is sent to a particular part of the brain - the visual cortex in the occipital lobe at the

back of the brain.

PROCESS OF VISION

PART 1 - LIGHT INFORMATION COLLECTED IN THE EYE AND ORGANISED TO GO TO THE BRAIN

Figure 1 shows the stages in the process of light entering the eye and crossing it to the retina, while figure 2 outlines the basic physiology of the eye.

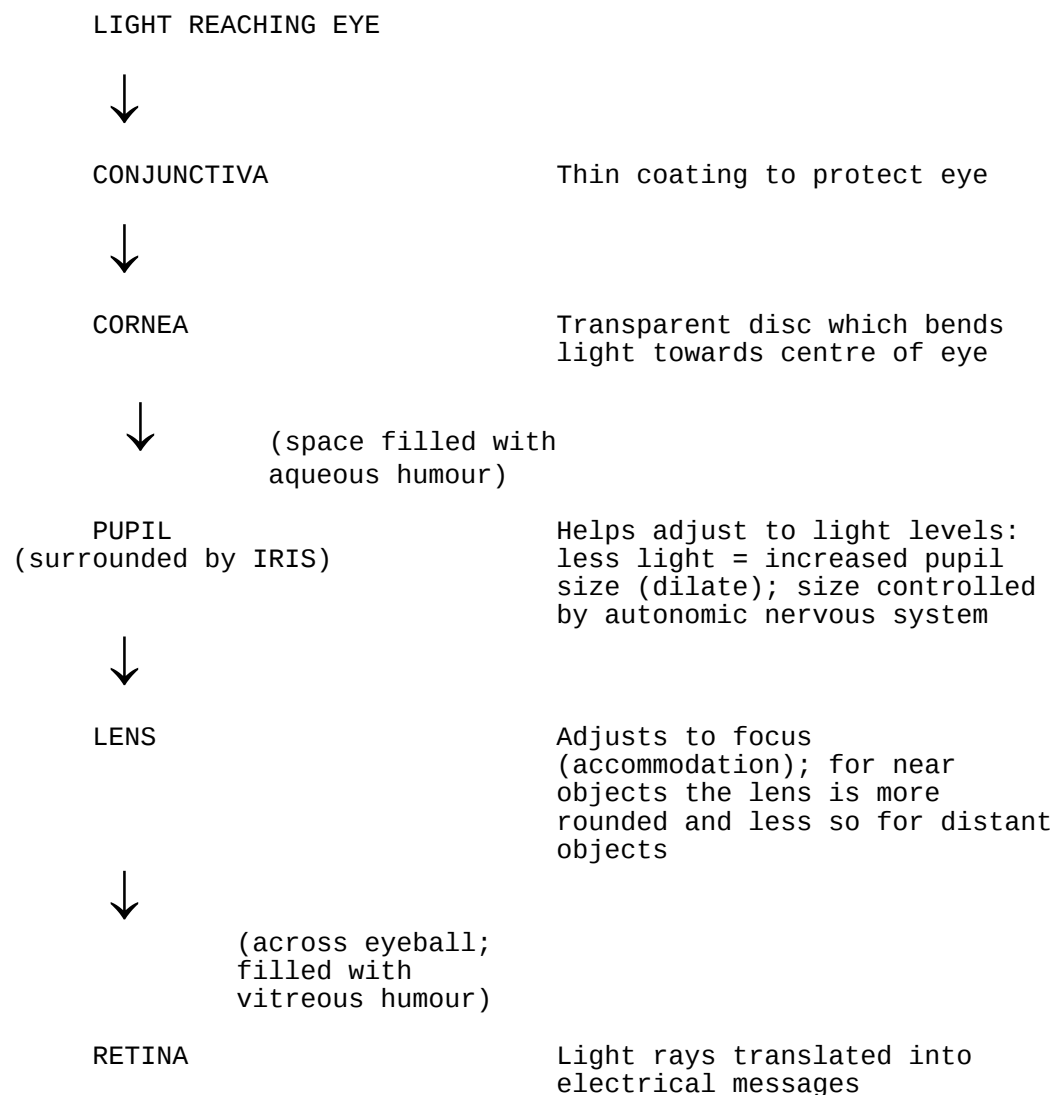
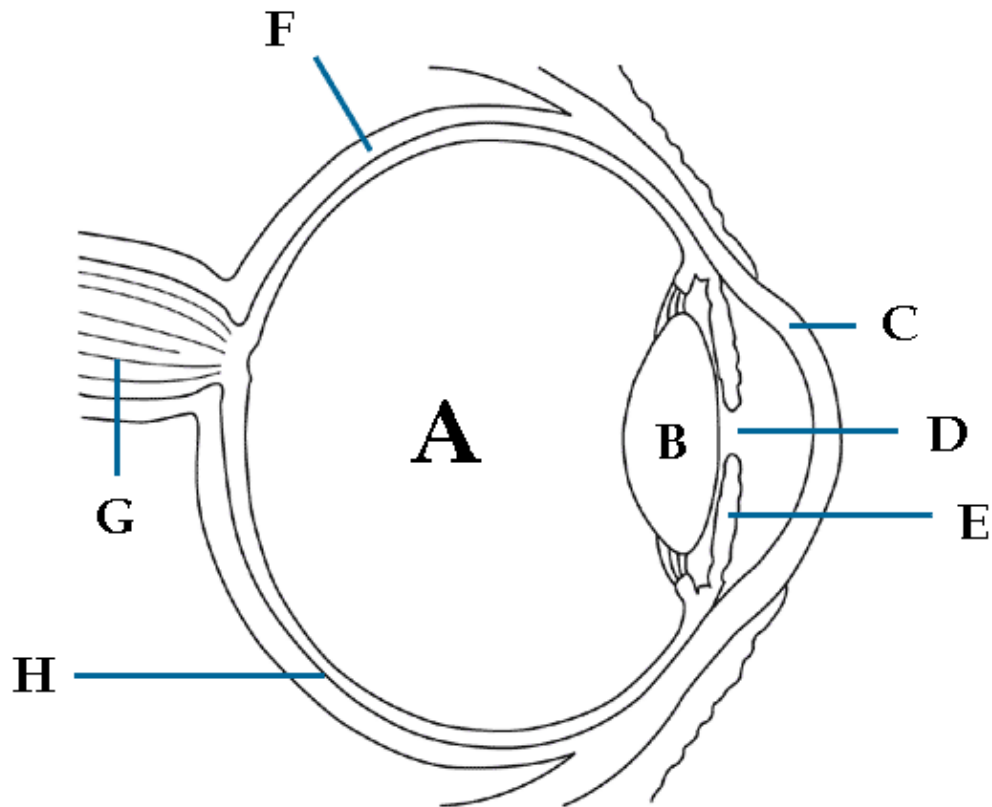


Figure 1 - Stages of light entering the eye.



A - Vitreous humour, B - Lens, C - Cornea, D - Pupil, E - Iris, F - Sclera, G - Optic Nerve, H - Retina

(Source: National Eye Institute modified by User Nordelch; public domain)

Figure 2 - Basic physiology of the eye.

Ornstein (1975) described the eye as "most important avenue of personal consciousness". It should be noted that the eye is not the same as a camera (table 1).

	CAMERA	EYE
Quality of image	High	Low - eg: curvation of retina means straight lines are curved
Steadiness of image	Use of tripod	Makes sudden, intermittent jumps of eye position every second (saccades), and brain removes them to give impression of constant picture; shown by use of eye trackers; eg: contact lens with tiny cameras fitted (Pritchard 1961)
Transmission of information	Camera to TV - whole image	Patterns extracted by retina, and information sent to brain
Moving objects	Follows if camera moved	Convergence (movement of eyes in sockets) allows fixation on moving objects
Optic array (visual field)	Focuses equally on all parts of visual field	Focuses on small area with high acuity (central/foveal visual field) and remainder (peripheral visual field) with low acuity (accuracy of vision)

Table 1 - The eye and the camera.

PART 2 - TRANSMISSION OF ELECTRICAL MESSAGES TO THE VISUAL CORTEX

On the retina, at the back of the eye, light is transformed into electrical signals. Technically, the process occurs through chemicals which change with light and set off small electrical charges. These charges are sent along over one million ganglion cells to the brain. Where the axons are bunched together on the retina is called the "blind spot".

The retina contains rods, which respond to dim light, and cones for bright light and colour. There are estimated to be 131 million cones and rods. The ability of rods and cones is measured in foot-lamberts (1 foot-lambert = amount of light from the surface of an object 1 foot located 1 foot from a standard candle).

Rods and cones respond to differently to light (figure 3). The cones adapt quickly to light changes, while the rods take up to an hour to adapt fully.

		ROD VISION ↓
THRESHOLD	10×-6 ft-lamberts	
WHITE PAPER IN STARLIGHT	10×-4	
WHITE PAPER IN MOONLIGHT	10×-2	
	1	
		CONE VISION ↓
COMFORT READING	10	
WHITE PAPER IN SUN	10×4	
LIGHT BULB	10×6	
SUN AT NOON	10×9	DAMAGE TO RETINA

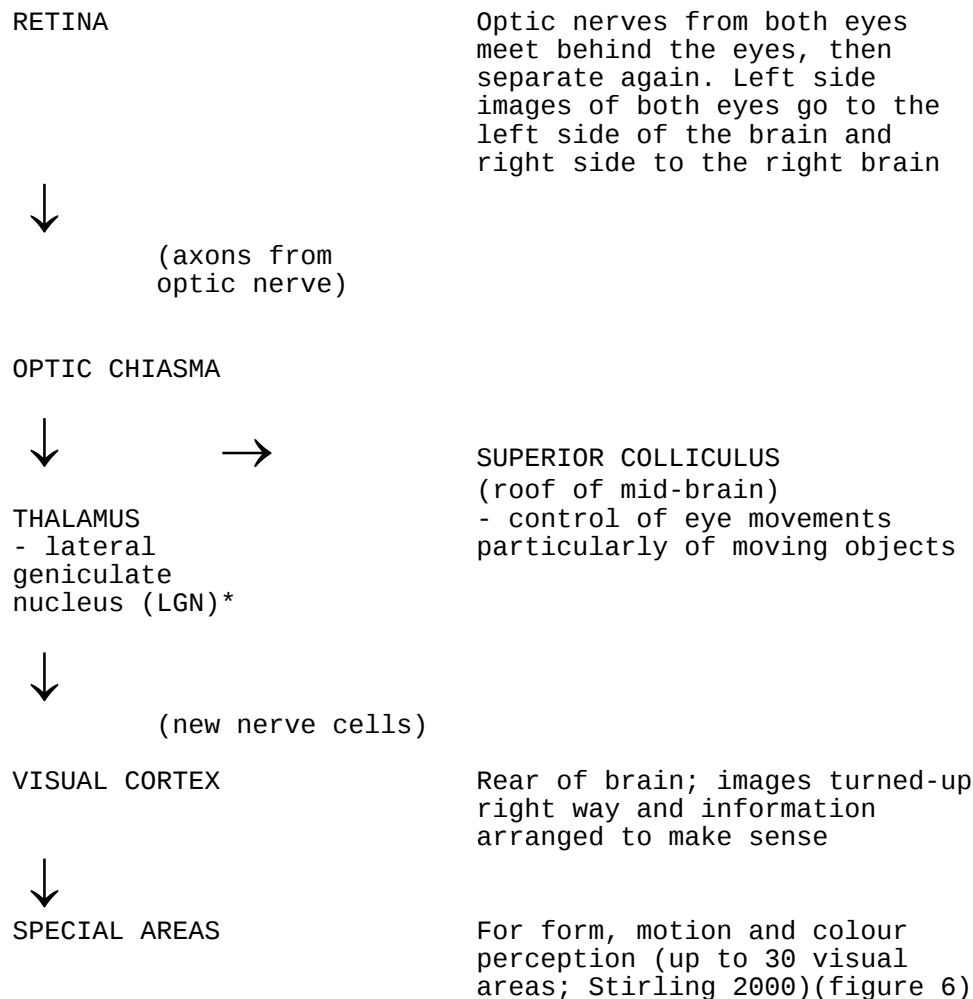
Figure 3 - Different strengths of light.

Figures 4 and 5 outline how the visual information gets from the retina to the visual cortex.

Researchers have distinguished two separate pathways through the brain for visual information (Holmes 1998):

i) "Northern pathways" - for information about movement and spatial perception. This is a faster pathway and involves immediate responses; eg: to danger. It is probably at an unconscious level;

ii) "Southern pathway" - for perception of colour, form and object recognition. This is linked to conscious perception.



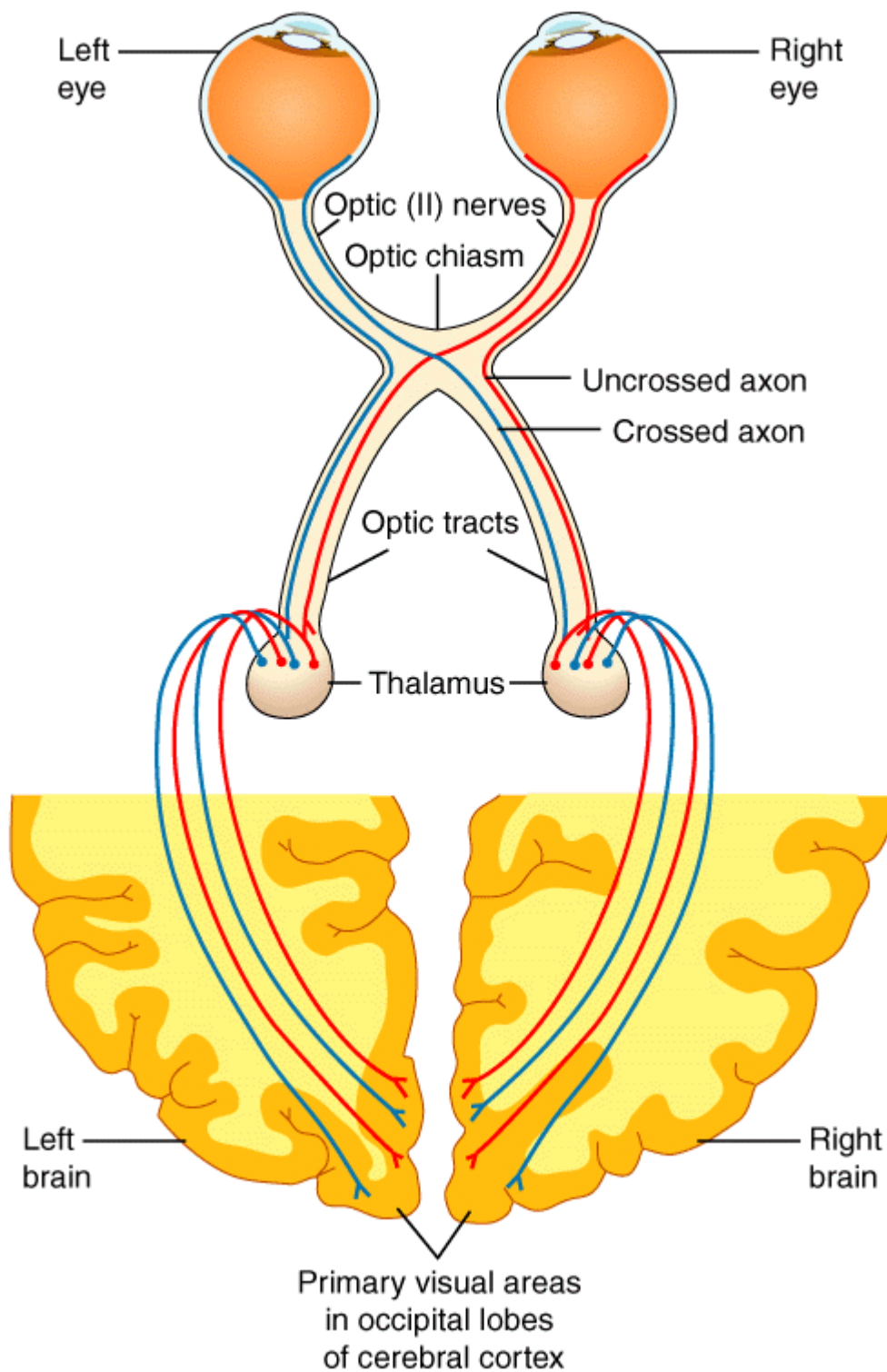
(* Originally believed only relay station for sensory information where signals transferred to new nerve cells. Evidence that cells integrate signals about movement)

Figure 4 - From retina to visual cortex.

WHEN DO WE ACTUALLY SEE?

With lower order species, vision takes place in the eye. For example, the retina of the frogs contains certain cells that respond to moving objects that are black and fly-sized at the length of the tongue away (Tinbergen 1974).

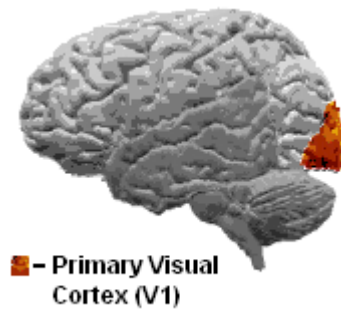
But for higher order species, like mammals, vision takes place in the brain. Evidence to support this idea comes from cases of individuals who suffer brain injury to visual cortex, and the eyes are unharmed, yet the individual cannot see. This was first noticed in World War I with soldiers who had shrapnel embedded in the back of their skull. The eyes were undamaged, but the soldiers had a loss of vision.



(Source: Wiley ¹)

Figure 5 - Cross-section of visual pathways in brain.

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(Source: Chavez01; public domain)

Figure 6 - Side view of the brain and the specialist visual area.

More recently, there are cases of "blindsight" (Weiskrantz 1986). This is where individuals report complete blindness or partial blindness in a particular area of the visual field, but are still able to detect whether a visual stimulus has been presented in the blind area. One case known as "D.B" (Weiskrantz et al 1974) had a brain operation for severe migraine which damaged the visual cortex. This is also evidence for unconscious perception ("northern pathway"), and the importance of the LGN in vision.

However, to make vision more effective, certain processes take place in the retina before electrical signals are sent to the brain.

VISUAL INFORMATION PROCESSING

In order to improve the efficiency of vision, the retina does not simply send every piece of information to the brain. There is an element of visual processing which occurs at the retinal level. This can be seen in three aspects of vision - contrast processing, sensory adaptation, and the perception of colour. The key is to reduce the amount of information sent to the brain.

i) Contrast processing - one way to increase the efficiency of vision is to concentrate on detecting contrasts in the visual information. In figure 7, the edges of the black rectangle are emphasised against the white background.

Edge detection is an example of contrast processing. This occurs through a process known as lateral inhibition. Within the retina, when particular cells are stimulated, they inhibit activity in the adjacent cells. In other words, the cells that are stimulated become emphasised, thus the focus on edges and contrasts in the visual environment.



Figure 7 - Example of contrast processing.

ii) Sensory adaptation - this is the ability of the eyes to adapt to darkness, for example, after initially being unable to see. The same is true in over-bright conditions. This is known as dark-light adaptation. Rods and cones are involved in this process.

iii) Perception of colour - colour is processed in the retina initially by cone cells, and then, to some degree, in the thalamus (Clark 1998).

REFERENCES

Atkinson, R.L; Atkinson, R.C; Smith, E.E & Bem, D.J (1990) Introduction to Psychology (10th ed), New York: Harcourt Brace Jovanovich

Clark, A (1998) Perception: Colour. In Bechtel, W & Graham, G (eds) A Companion to Cognitive Science, Oxford: Blackwell

Holmes, R (1998) Irresistible illusions, New Scientist, 5/9, 31-37

Ornstein, R.E (1975) Psychology of Consciousness, New York: W.H Freeman

Pritchard, R.M (1961) Stabilised images on the retina, Scientific American, 204, 72-78

Stirling, J (2000) Cortical Functions, London: Routledge

Tinbergen, N (1974) Animal Behaviour (rev ed), Netherlands: Time-Life

Weiskrantz, L (1986) Blindsight: A Case Study and Implications, Oxford: Clarendon

Weiskrantz, L; Warrington, E; Sanders, M & Marshall, J (1974) Visual capacity in the hemianopic field following a restricted occipital ablation, Brain, 97, 709-728

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(Diagrams from http://commons.wikimedia.org/wiki/Main_Page; updated May 2009)

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